Sudan University of Science and Technology
College of Graduate Studies

Measurement of Normal Kidneys Length using Ultrasonography in Khartoum State

قياس طول الكلى الطبيعية
باستخدام التصوير بالموجات فوق الصوتية فى ولاية الخرطوم

A thesis Submitted for Partial Fulfillment of the Requirements of M.Sc Degree in Medical Diagnostic Ultrasound

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الآية

بسم الله الرحمن الرحيم

قـال الله تـعـالـى :
(لا يُكَلِّفُ اللَّهُ نَفْساً إِلَّا وُسْعَهَا لَهَا مَا كَسَبَتْ وَعَلَيْهَا مَا اكْتَسَبَتْ رَبَّنَا لا تُؤَاخِذْنَا إِنْ نَسِينَا أَوْ أَخْطَأْنَا رَبَّنَا وَلا تَحْمِلْ عَلَيْنَا إِصْراً كَمَا حَمَلْتَهُ عَلَى الَّذِينَ مِنْ قَبْلِنَا رَبَّنَا وَلا تُحَمِّلْنَا مَا لا طَاقَةَ لَنَا بِهِ وَاعْفُ عَنَّا وَاغْفِرْ لَنَا وَارْحَمْنَا أَنْتَ مَوْلانَا فَانْصُرْنَا عَلَى الْقَوْمِ الْكَافِرِينَ)

صدق الله الـعـظـيـم
سـورة الـبـقـرة الآيـة (286)

Dedication

To the spirit of my father ,

my mother ,

sister Ommali ,

husband Elshfie ,

friends and those who spend their time teaching residents.

Acknowledgment

I would like to express my deepest gratitude to my supervisor Dr. Babiker Abd Elwahab Awad Alla for his valuable guidance, helpful , suggestions and continuous encouragement and direction . I'm grateful to those colleagues who collecting the data and without their help this work would not have come out.

May almighty Allah make this research of special benefit to the development of health services in Sudan.

Abstract

This was across sectional descriptive study conducted in sudan khartoum state in Alsifa center , Ahbab almustafa center and Almutakamel center from November to December 2018. The problem of the study was need to determine reference values for normal length of kidneys in Sudanese population. The aim to measure of normal renal length using ultrasonography. The data was collected from 102 population (71 females, 31 males) and analysis by SPSS (Statistical Package for the Social Sciences). The study found that mean of renal length were (9.655 cm), SD was(1.0124) for the right kidney and (10.105 cm), SD was(1.0352) for the left kidney.

These result were correlated with age and found in male the mean was (43.10) and SD was (18.755), and found in female the mean was (38.87) and SD was (15.531).

These result were correlated with sex and found in male the mean of Rt kidney was (9.800) the SD was (0.9227); the mean of Lt kidney was (10.129), the SD was (.9991), and found in female the mean of Rt kidney was(9.592), the SD was(1.0490), the mean of Lt kidney was (10.094), the SD was (1.0573).

The study concluded that there was correlation between age and the length of the kidneys The kidney length in males is slightly more than females, the left kidney length larger than the right.

Study recommended that further studies should be done with large sample size (Some of the limitations in this study were the smaller sample size, the sample size must be large enough to detect the clinically important effect), and use other modalities like CT, MRI to confirm the accurate normal measurements.

المستخلص

هذه دراسة وصفية تمت في مركز الشفاء , مركز أحباب المصطفى ومركز المتكامل بولاية الخرطوم في الفترة من شهر نوفمبر حتى شهر ديسمبر . أجريت هذه الدراسة لقياس طول الكلى الطبيعية للسودانيين لتكون قيمة مرجعية لطول الكلى الطبيعى . والهدف من هذه الدراسة هو قياس طول الكلى الطبيعى بالموجات فوق الصوتية . تم جمع البيانات بفحص (102) سودانياَ (31 ذكور , 71 إناث) بناءً على العمر والجنس . وجدت الدراسة أن متوسط طول الكلية اليمنى هو (9.655) , الانحراف المعيارى هو (1.0124) ومتوسط طول الكلية اليسرى هو (10.105), الانحراف المعيارى هو(1.0352) .

هذه النتائج إرتبطت بالعمر حيث وجدت في الذكور أن متوسط طول الكلية هو (43.10) , الانحراف المعيارى هو (18.755) . أما في الاناث فوجدت أن متوسط طول الكلية هو (38.87) , الانحراف المعيارى هو (15.531).

هذه النتائج إرتبطت بالجنس حيث وجدت في الذكور أن متوسط طول الكلية اليمنى هو (9.8) , الانحراف المعيارى هو (.9227) ومتوسط طول الكلية اليسرى هو (10.129) , الانحراف المعيارى هو (.9991) . أما في الاناث فوجدت أن متوسط طول الكلية اليمنى هو (9.592) , الانحراف المعيارى هو (1.0490) , ومتوسط طول الكلية اليسرى هو (10.094) , الانحراف المعيارى هو (1.573).

خلصت الدراسة الى أن هنالك ارتباط فى طول الكلى مع العمر والجنس وأن طول الكلى عند الذكور أكثر منه عند الاناث , وأن الكلية اليسرى أطول من اليمنى عند الجنسين .

أوصت الدراسة باجراء المزيد من الدراسات لإيجاد قيمة مرجعية لطول الكلى وذلك بزيادة عدد المتطوعين والتغلب على الصعوبات التى واجهت هذه الدراسة ,وإستخدام وسائل أخرى مثل الرنين المغنطيسى والأشعة المقطعية لقياس طول الكلى الطبيعى .

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List of Abbreviations

CT	Computerized Tomography
Lt	Left
MRI	Magnetic Resonance Imaging
PT	Patient
Rt	Right
SD	Standard Deviation
US	Ultrasound

Introduction

1.1Introduction:

The kidney size of a patient is a valuable diagnostic parameter in urological and nephrological practice. While the leading anatomy text describes the adult kidney as 12 cm long, 6 cm wide and 3 cm deep (Gray, Henry, 1995), further review of the literature shows that renal size varies with age, gender, body mass index, pregnancy and co-morbid conditions. Renal size may be an indicator for the loss of kidney mass and therefore, kidney function.(Guzman RP, et al, 1994)**.**

It is valuable in monitoring unilateral kidney disease through comparison with the other, compensatorily increased side (Yamaguchi S, et al, 1990) and for the discrimination between upper and lower urinary tract infections. (Dinkel E, et al, 1986).

Renal infections/inflammations, nephrologic disorders, diabetes mellitus and hypertension are the most important co-morbid conditions affecting renal size (Montague JP, et al, 1982) (Yamada-H, et al, 1992).
Since the renal size is affected by various factors, it is necessary to first establish the normal values. The information available may not be extrapolated to our population since the renal size may differ according to body size (Emamian Sa, et al, 1993).

While population-based studies are needed to establish the normal values for Sudanese individuals, in our study we determined the ultrasonography renal size in a group of individuals with no known renal disease and assessed the effect of age and gender.

There are several methods measuring renal size, including abdominal CT and MRI. However, these approaches have disadvantages such as radiation exposures and high costs. In comparison, ultrasonography (US) is a safe, noninvasive and a simple method for evaluating renal length.

1.2 Problem of study

Measurement the size of kidneys is very important because kidneys are vital organs that need accurate findings to diagnosing specially in adult. Also needed to revel if the growth of vital organ as kidney is affected by ages and sexes.

1.3 Objective of the study:

1.3.1 General objective:

To Measure the normal kidneys length in Sudanese using ultrasound.

1.3.2 Specific objectives:

- To measure the length of the right and left kidneys in Sudanese.
- To assess the effects of age in the kidneys length.
- To correlate the values of length with gender in Sudanese.

1.3.3 Significance of the study:

The study will determine the normal value of both right and left kidneys length among Sudanese. This will facilitate diagnosis of any changes due to pathologic conditions.

1.4 Overview of the study

This study fall into five chapters:

Chapter one: Are the introduction, problem and objectives.

Chapter two: literature review.

Chapter three: material and method.

Chapter four: deal with data presentation and data analysis (Result)

Chapter five: contain discussion of the result, conclusion and recommendation

Literature review and previous studies

2-1 Renal Anatomy:

The two kidneys are located in the upper abdominal cavity on either side of the vertebral column, behind the peritoneum (retroperitoneal). The upper portions of the kidneys rest on the lower surface of the diaphragm and are enclosed and protected by the lower rib cage .The kidneys are embedded in adipose tissue that acts as a cushion and is in turn covered by a fibrous connective tissue membrane called the renal fascia, which helps hold the kidneys (Bajwa and Kasi, 2018).

Kidneys in place in the supine position, the kidneys extend from approximately vertebra TXII superiorly to vertebral III inferiorly, with the right kidney somewhat lower than the left because of its relationship with the liver. Although they are similar in size and shape, the left kidney is a longer and more slender organ than the right kidney, and nearer to the midline. Each kidney has an indentation called the hiluson its medial side. At the hilus the renal artery enters the kidney, and the renal vein and ureter emerge. The renal artery is a branch of the abdominal aorta, and the renal vein returns blood to the inferior vena cava, the ureter carries urine from the kidney to the urinary bladder(Favorito, 2017).

The Right Adrenal (Suprarenal) Gland sits on a s Anterior mall part of the anterior surface of the upper pole and upper part of the medial border. The adrenal gland is separated from the kidney by peri-renal fat. The Right Lobe of the Liver covers approximately three-quarters of the anterior surface of the kidney(Bajwa and Kasi, 2018).

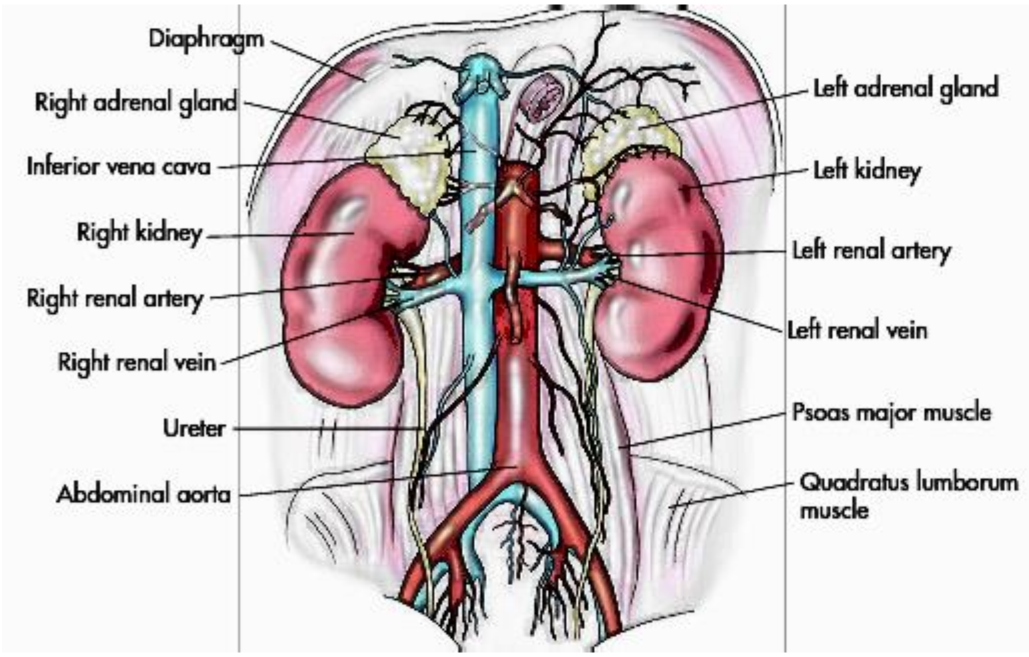

Figure 2-1 Anatomy of the kidneys: Anterior surface Relationships of the Kidneys **(**L.Hagen, 2012)

The Descending Duodenum over lies a narrow area on the medial border. Other portions of the small Intestine cover a small portion of the lower anterior surface The Body/Tail of the Pancreas and Splenic Vessels are related to the middle of the anterior surface of the left kidney. The Splenic Flexure of the Colon is related to a portion of the anterolateral surface of the inferior half of the kidney. The Jejunum overlies the lower medial anterior surface. This is the first coil which occupies a recess between the left part of the transverse mesocolon and the left kidney. The rest of the jejunum lies in the umbilical region(Tarzamni et al., 2016).

The posterior surfaces are embedded in fat and are devoid of peritoneum. The diaphragm is related to the posterior surfaces of the upper poles of the kidneys.

The psoas major muscles have a relationship to the medial portions of the posterior surfaces of the kidneys. The quadratus lumborum muscles are related to the central portions of the posterior surfaces. The aponeuroses of the transversus abdominis muscles are related to the lateral portions of the posterior surfaces(Favorito, 2017).

Internal structure of the kidney in a coronal or frontal section of the kidney, three areas can be the lateral and middle areas are tissue layers, and the medial area at the hilus is a cavity. The outer tissue layer is called the renal cortex. The outer cortex of the kidney is darker than the inner medulla because of the increased perfusion of blood (Sandra) it is made of renal corpuscles and convoluted tubules. These are parts of the nephron.

The inner tissue layer is the renal medulla, which is made of loops of Henle and collecting tubules (also parts of the nephron). The renal medulla consists of wedge-shaped pieces called renal pyramids. The tip of each pyramid is its apex or papilla. The third area is the renal pelvis; this is not a layer of tissues, but rather a cavity formed by the expansion of the ureter within the kidney at the hilus. Funnel shaped extensions of the renal pelvis, called calyces (singular: calyx), enclose the papillae of the renal pyramids. Urine flows from the renal pyramids into the calyces, then to the renal pelvis and out into the ureter.

The nephron is the structural and functional unit ofthe kidney. Each kidney contains approximately 1 million nephrons. It is in the nephrons, with their associated blood vessels, that urine is formed. Each nephron has two major portions: a renal corpuscle and arenal tubule. A renal corpuscle consists of a glomerulus surrounded by a Bowman's capsule. The glomerulus is a capillary network that arises from an afferent arteriole and empties into an efferent arteriole.

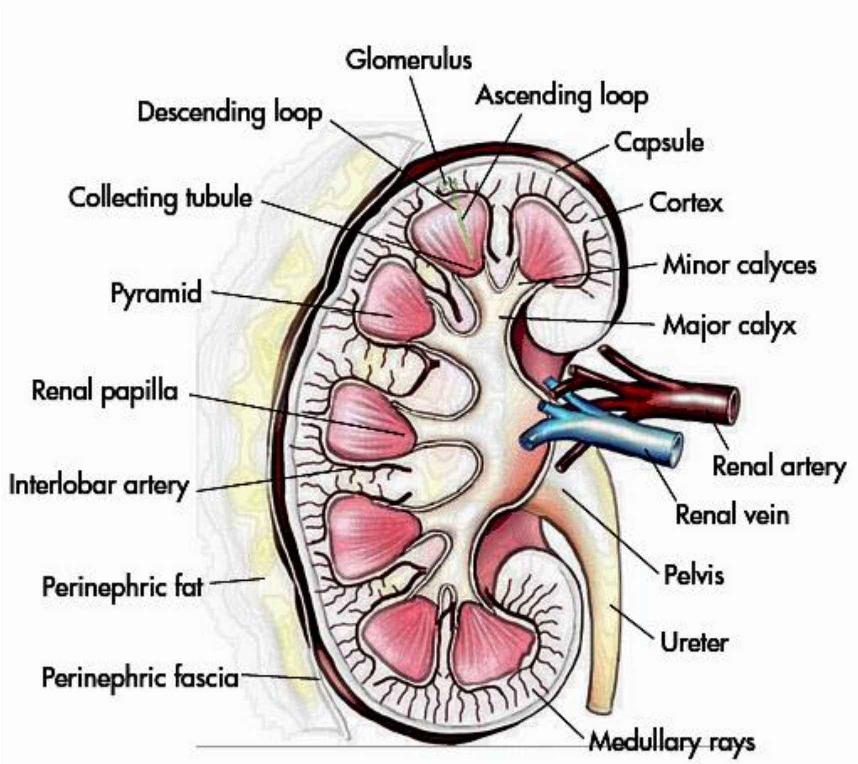

Figure (2.2) Coronal section of the kidney show internal structures.(L.Hagen 2012)

The diameter of the efferent arteriole is smaller than that of the afferent arteriole, which helps maintain a fairly high blood pressure in the glomerulus.Bowman's capsule(or glomerular capsule) is the expanded end of a renal tubule; it encloses the glomerulus. The inner layer of Bowman's capsule is made of podocytes; the name means "foot cells," andthe "feet" of the podocytes are on the surface of the glomerular capillaries. The arrangement of podocytes creates pores, spaces between adjacent "feet," which make this layer very permeable(Zomorrodi et al., 2010).

The outer layer of Bowman's capsule has no pores and is not permeable The space between the inner and outer layers of Bowman's capsule contains renal filtrate, the fluid that is formed from the blood in the glomerulus and will eventually.

The renal tubule continues from Bowman's capsule and consists of the following parts: proximal convoluted tubule (in the renal cortex), loop of Henle (or loop of the nephron, in the renal medulla), and distal convoluted tubule (in the renal cortex). The distal convoluted tubules from several nephrons empty into a collecting tubule. Several collecting tubules then unite to form a papillary duct that empties urine into a calyx of the renal pelvis. Cross-sections of the parts of the renal tubule are shown in Notice how thin the walls of the tubule are, and also the microvilli in the proximal convoluted tubule(Rumballe et al., 2010).

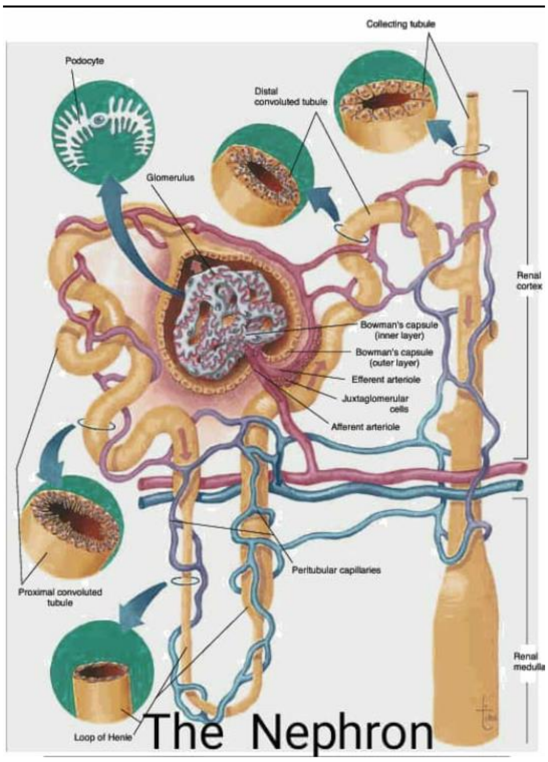

Figure (2.3) The Nephron(Valerie C.Scanlon 2007)

The lymphatic drainage parallels the venous drainage system. After leaving the renal hilum, the left primary lymphatic drainage is into the left lateral aortic lymph nodes, including nodes anterior and posterior to the aorta between the inferior mesenteric artery and the diaphragm. On the right, it drains into the right lateral caval lymph nodes. (Christian Kurts, Ulf Panzer, Hans-Joachim Anders & Andrew J. ReesNature Reviews Immunology13,738–753(2013)doi:10.1038/nri3523)

The kidney receives autonomic supply via both the sympathetic and parasympathetic portions of the nervous system. The pre-ganglionic sympathetic nervous innervations to the kidneys arises from the spinal cord at the level of T8-L1. They synapse onto the celiac and aorticorenal ganglia and follow the plexus of nerves that run with the arteries. Activation of the sympathetic system causes vasoconstriction of the renal vessels. Parasympathetic innervation arises from the 10th cranial nerve (X), the vagus nerve, and causes vasodilation when stimulated

2-1-6 Natural Variants

Anatomic variations in the renal vasculature occur in approximately 25-40% of patients. Supernumerary, or accessory, renal arteries are the most common arterial variation, with most of these branches supplying the lower pole of the kidney. They may pass anterior to the inferior vena cava (IVC) and over the ureteropelvic junction and be associated with (or cause) obstruction of the ureteropelvic junction (UPJ). Persistence of the right subcardinal vein anterior to the ureter can lead to a retrocaval ureter, which can also cause obstruction.

Kidney position in the retroperitoneum is subject to variation as well. A kidney may be in an ectopic location, such as the pelvis, when it does not ascend properly, or it can be malrotated or fused (as in horseshoe kidneys, in which the inferior poles are fused, causing a U-shaped configuration). In some fusion anomalies, such as crossed-fused ectopia, the two kidneys may be located on the same side. Although some of these variations may be associated with pathological conditions, such as hydronephrosis and UPJ obstruction, they can also remain completely asymptomatic and undiscovered until a diagnosis is made by radiographic study. Importantly, in an ectopic kidney, the adrenals should still be in the superior portion of the posterior peritoneum, since their embryologic origin is different from that of the kidneys. Variants may also exist in the collecting system drainage. Duplication anomalies may develop, wherein more than a single collecting system may form and drain separately into the bladder (complete duplication) or join at some point proximally before draining into a single orifice into the urinary bladder (partial duplication). In a complete duplicated system, the upper pole moiety drains inferomedially into the bladder, and the lower pole moiety drains superolaterally, as described by the Weigert-Meyer rule.

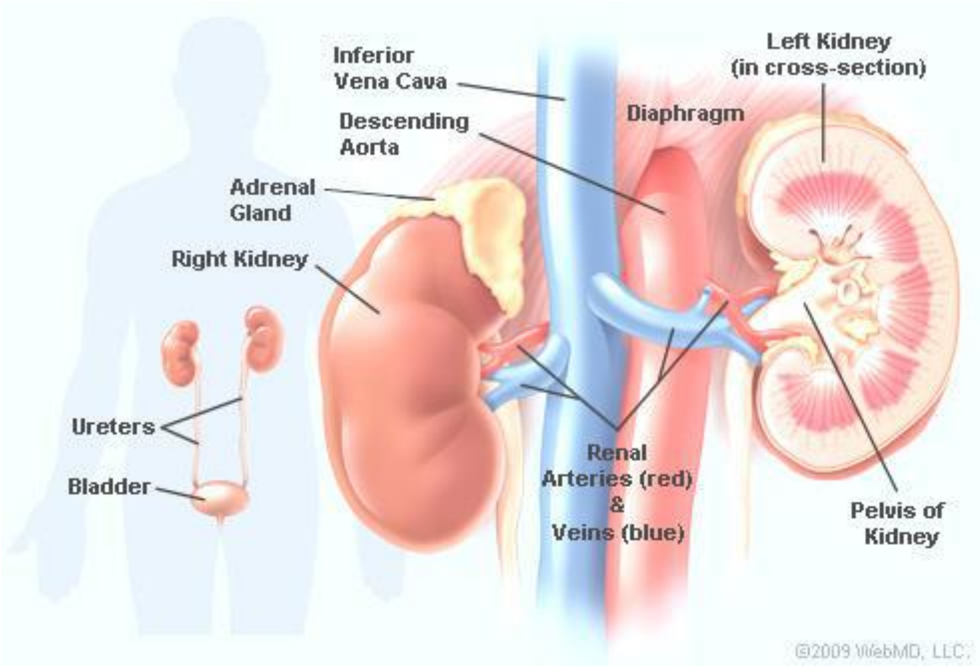

Fig (2. 4) shows longitudinal section of the urinary system and relation with great vessels. (http://www.medicinenet.com/image-collection/kidneys_picture/picture.htm, 2009)

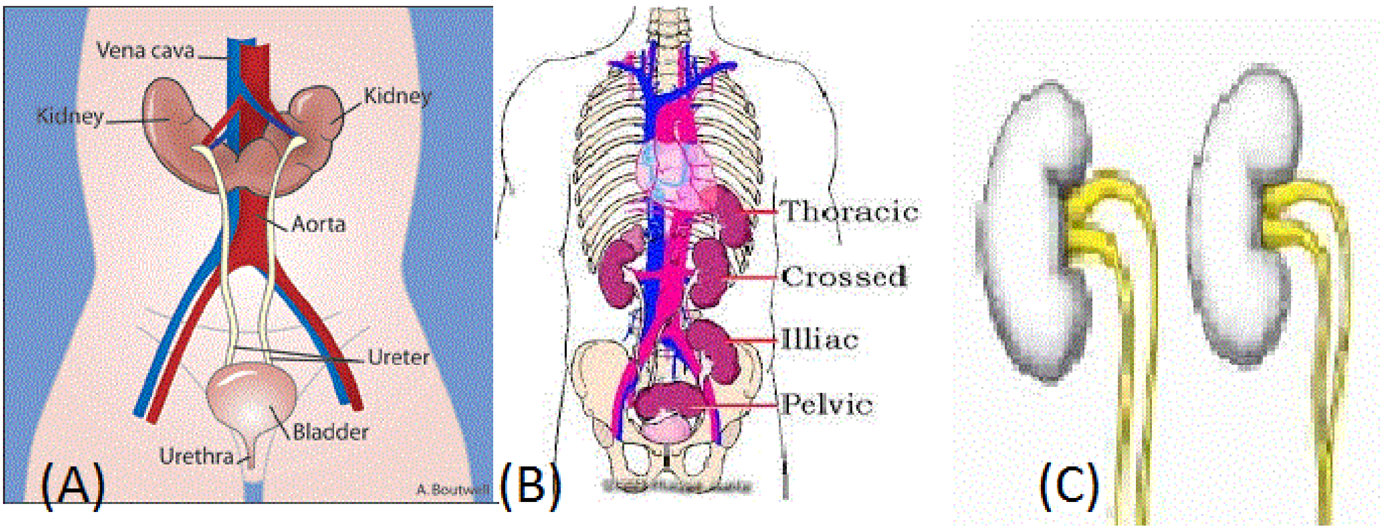

Fig (2-5) A showing fusion anomaly, B ectopic kidneys and C duplication anomalies

2-2 Renal physiology:

The formation of urine involves three major processes. The first is glomerular filtration, which takes place in the renal corpuscles. The second and third are tubular reabsorption and tubular secretion. The kidneys form urine from blood plasma. Blood flow through the kidneys is a major factor in determining urinary output. Glomerular filtration is the first step in urine formation. Filtration is not selective in terms of usefulness of materials; it is selective only in terms of size. High blood pressure in the glomeruli forces plasma, dissolved materials, and small proteins into Bowman's capsules; the fluid is now called renal filtrate. Tubular reabsorption is selective in terms of usefulness. Nutrients such as glucose, amino acids, and vitamins are reabsorbed by active transport and may have renal threshold levels. Positive ions are reabsorbed by active transport and negative ions are reabsorbed most often by passive transport (Lu and Gu, 2017).

Water is reabsorbed by osmosis, and small proteins are reabsorbed by pinocytosis. Reabsorption takes place from the filtrate in the renal tubules to the blood in the peritubular capillaries. Tubular secretion takes place from the blood in the peritubular capillaries to the filtrate in the renal tubules and can ensure that wastes such as creatinine or excess H ions are actively put into the filtrate to be excreted. Hormones such as aldosterone, ANP, and ADH influence the reabsorption of water and help maintain normal blood volume and blood pressure. The secretion of Anti Diuretic Hormone (ADH) determines whether concentrated or dilute urine will be formed. Waste products remain in the renal filtrate and are excreted in urine(Starling, 2017).

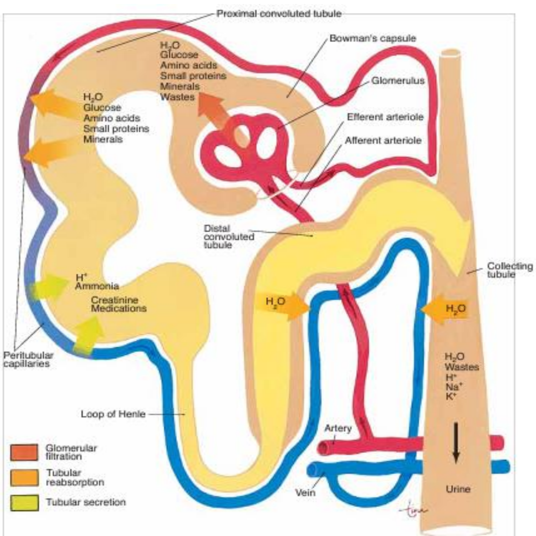

Figure (2.6) glomerular filtration, tubular reabsorption and tubular secretion (Valerie, 2007)

2-3 Normal Size of Kidney:

It is easier to visualize the pyramids in children and young adults; the central echo complex (the renal sinus) is imaged as a very highly hyper echoic (very echogenic) area, normally occupying about one third of the kidney and includes the collecting system (pelvis and calyces) and renal vessel. It is the most part of the kidney and has greater echogenicity due to the fat deposition. The sinus is surrounded by the parenchyma (the area from the renal sinus to outer renal surface) whose thickness is 11-18mm in male and 11-16 mm in female. The pelvis is not visualize unless there is urine filled when it appear anechoic it is scanned through the renal sinus in an anterior transverses vein. (Gratton, Denis, 2005)

Fig (2.7) shows the normal longitudinal of the kidney

The renal arteries and veins are best seen at hilum. They enter the kidney at different levels and may be multiple. The accurate vessels are demonstrated as intense specular echoes in cross section or oblique section at the corticomedullary junction. The renal arteries are best seen in supine and lateral decubitus views. The right renal artery can be seen in a longitudinal scan as a circular structure posterior to the inferior vena cava. The right renal vein extends from the central renal sinus directly in to the IVC. Both vessels appear as tubular structures in the transverse plane the renal arteries have an echo free central lumen with highly echogenic borders that consist of vessel wall and the surrounding retroperitoneal fat and connective tissue. They lie posterior to the veins and can be demonstrated with certainly if their junction with the aorta is seen. The left renal artery flows from the posterior-lateral wall of the aorta to the central renal sinus. An extra renal pelvis may be seen as a fluid filled structure medial to the kidney on transverse scans.

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Differentiation of the normal variant from obstruction is made by noting the absence of intra sinus distention of the renal pelvis and infundibula. Dilatation of the collecting system has also been noted in pregnancy (the right kidney is generally involved with mild degree of hydronephrosis which reverts to normal after delivery). Normally in the non hydrated subject the renal pelvis is collapsed and therefore not demonstrated on the scan. (Gratton, Denis, 2005)

The renal pelvis is influenced by bladder distention, diuretics and the state of hydration. Distention of the renal pelvis is seen in 50% of non hydrated and in 90% in hydrated subjects examined with a full bladder. The normal renal pelvis in the hydrated patients is between 2-14 mm. If two separated collection of renal sinus fat are identified a double collecting system should be suspected ability to visualize the kidney close not mean that it is functioning. To assess renal function use contrast urography, Arachio nuclide study or laboratory test, injury to kidney may result in temporary loss of function.

Normal ureters are not always seen. They should be sought where they leave the kidney at the hilum. They may be multiple and are often seen in the coronal projection generally, echogenicity from higher to decreasing order is: renal sinus, spleen, liver, renal cortex renal medulla in adult. The thickness of the renal parenchyma decrease at about 10% per decade after 20 years of age. The corticomedullary ratio is 1:1.6 up to 30 years old; 1:1.2 up to 50 years old 1:1 above 50 years old with thinning of cortex with age. The overall size decreases with age and only apparent in the elderly. The fetal kidney size in cm. equals the gestational age in weeks plus or minus 3mm. infantile kidneys are large compared to overall body size typically 4-5cm long at birth and may be imaged from 12-14 weeks on wards but clearly seen after 16 weeks. (Gratton, Denis, 2005).

In transverse section they appear hypoechogenic, circular structures on either side of the spine. Within them can be seen the strongly echogenic renal pelvis, the capsule is also echogenic; The renal papilla is hypoechoic and can appear large. Some dilatation of the renal pelvis less than 5 mm may sometimes be seen but it is normal finding. It is important to assess renal size by comparing the renal circumference with the abdominal circumference; the normal ratio being 0.27-0.3 the fetal urinary bladder can be recognized as a small avoid cystic structure within the fetal pelvis as early as 14-15 weeks. The normal urinary production at 22 weeks in 2m1 per hour, whereas at full term it is 26ml per hour until the age of 6 month. (Gratton, Denis, 2005)

Neonatal kidney differs acoustically from adult kidneys in that, the difference between cortex and medulla is less marked in the infant pyramids are relatively, hypoechoic and may resemble cysts cortex is less echogenic than Liver parenchyma. For the first 3 years of life; its pyramid appear large because the cortex is relatively thin and hyperechoic. During the first year of life the cortex gradually develops to assume the adult corticomedullary proportion. The pediatric renal sinus is poorly echogenic because it contains little fat. (Gratton, Denis, 2005).

Fat deposition and accumulation occurs gradually to achieve adult proportions by about age 10 years, the majority of infants have a slight separation of the central echo complex reflecting the presence of a small amount of urine of unknown cause. There is no absolute measurement to separate normal distension from hydronephrosis 10mm separation is considered the upper limit of normal. “Unlike in adult practice detection of children with vesicoureteric reflux is important and may only be reflected by minor separation the central sinus echoes without renal scarring”. Normal renal length of pediatric kidney is determined using this guide: Renal length (over one year) in cm 6.79+ (0.22* age in years).

In those less than one year=4.98+ (0.155*age in months). “Asymmetry in renal lengths exceeding 5 mm in infants and 10 mm in older children should raise the suspicion of an underlying problem even if both kidneys are within the normal range.” (Gratton, Denis, 2005).

2.3 Renal Pathology

Approximately 10% of individuals have congenital abnormality of the urinary tract, some are hereditary. Congenital renal diseases may be malformation related to the volume of renal tissue formed or its differentiation. Anatomical abnormalities of position of vascular or ureteric connections. Metabolic lesions such as enzyme defects which affect tubular transport.

2. 3.1 Congenital megacalices

Congenital megacalices develop as result of an abnormality in the number and timing of divisions in the ureteral bud. Calices are increases in size and number and medullary thickness is decreased, whereas cortical thickness is normal, except in mild reduction in concentration ability. However, patients may develop stones and infection as a result of stasis. The sonographic appearance of large, clubbed calices extending into medullary region may mimic hydronephrosis or renal papillary necrosis, contrast radiography and clinical finding will help differentiate between these entities. (David Sutton, 2002).

2.3.2 Uretropelvic junction obstruction

Uretropelvic junction obstruction is a common congenital anomaly that rarely result in renal failure, unless it is sever or bilateral. In many cases, UPJ obstruction may go undiagnosed until adulthood even if discovered late, surgical repair may preserve renal function. Other genitourinary tract anomalies are frequently associated with PUJ obstruction, particularly a contralateral multicystic dysplastic kidney.

Sonographically: early in life show pelvocalectasis with an abrupt cut off of the pelvis dilation at the PUJ. Long standing cases detected in adults may present as a cystic mass without discemable renal parenchyma. In some cases differentiation of severe long standing PUJ obstruction from multicystic dysplastic kidney may impossible. (David Sutton, 2002).

2.3.3 Bilateral agenesis of the kidney Patter Syndrome

Is not compatible with independent life, it occurs in 0.04% of all pregnancies. Children with this condition have characteristic appearance low set ears; there is always a reduced volume of amniotic fluid due to absent of fetal urine. The most likely cause is a failure of the ureteric bud to develop; there are developments abnormalities also of other tissues derived from the mesonephrous, e, g bladder and genetelia, however, the commonly associated spinal cord abnormalities and pulmonary hyperplasia suggest that the defect is more generalized.

Unilateral agenesis of a kidney undergoes marked hypertrophy and is subsequently prone to infections and trauma. Children with this condition often do not survive long because of associated multiple developmental abnormalities, including congenital heart disease, spina bifida and menengomyocele. In renal hyperplasia the kidney is abnormally small but not otherwise malformed. Hypoplastic kidneys are prone to infection or stone formation. (David Sutton, 2002).

2.3.4 Disorders of differentiation

Renal dysplasia is a cause of cystic kidney which may present in child hood as an abdominal mass requiring surgical excision if only to exclude malignant tumor (e.g.Nephroplastoma). The lesion is characterized by islands of undifferentiated mesenchyme or cartilage within the parenchyma, if the lesion is unilateral the prognosis is good.

2.3.5 Metabolic malformation

Cyst in urea results from defective tubular reabsorption of several amino acids including cystine , lysine , ornithine and arginine the precise enzyme defect is unknown but some patient also have impaired intestinal transport cystine crystal are found in the urine and calculi may develop the disease is inherited as an autosomal recessive.

Renal tubular acidosis type (1) is probably due to a defect in the enzyme system which enables hydrogen ions to be exchanged for bicarbonate in the proximal tubule, there is loss of bicarbonate and failure to acidity and concentrate the urine, renal function is otherwise but there is a tendency to form stones and develop infections this condition is inherited as autosomal dominant gene, although an identical deficiency may be acquired as a result of tubular damage. Abnormalities in the kidney that can be detected by sonography include parenchyma or medical disease, obstructive uropathy, space, occupying lesions and renal vein thrombosis, abnormalities for size, shape and position are easily detected. Renal agenesis is suspected after through search in the abdomen and pelvic for ectopic organ, Duplication and mairotation can be shown. (David Sutton, 2002).

2.3.6 Space occupying lesions

Ultrasound is most common investigation performed to diagnosis masses suspected in sonographic examination. Its accuracy in detecting cystic versus solid lesions is nearly 100%.

2.3.7 Renal cysts and cystic disease

A simple and benign cyst is thin, walled and anechoic with distal enhancement. Cyst may be cortical or central in passion, when central they should be differentiated by their discrete shadow as compared to confluent shadows of hydronephrosis in poly cystic disease, the cyst are multiple and the kidney is large, there is often similar involvement of the liver, spleen, or pancreas. The symptoms of this abnormality usually renal failure do not develop before middle age. Medullary cystic disease is an autosomal recessive disease that remains silent until renal failure, cyst is confined to medulla and the kidney is small, Dysplastic multi cystic disease. Is unilateral the affected kidney in non functioning and there for bilateral disease is fatal, Hemorrhagic cyst and hematomas show both echo free and echogenic features with debris, fluid level.

2. 3.8 Renal abscess

Has variable echogenicity, generally hypoechoic with internal echoes there may be gas pocket within the abscess causing distal shadows. The development of renal or perinal abscess is an uncommon complication of renal infection.

2. 3.9 Renal mass

Renal cell carcinoma willims tumor and transitional cell carcinoma gives focal lesions lymphomas and leukemic infiltration, generalized enlargement of the kidney with an increase in echogenicity and diminished pelvicaliceal shadows.

2.3.10 Diffuse parenchymal lesion and renal failure

Small kidneys with parenchymal abnormalities occur in echogenic glomerulonephritis, chronic pyelonephritis and renal vascular disease. Renal failure due to mechanical renal disease increase the cortical echogenisity to level similar to or higher than those of adjacent liver or spleen, both acute and chronic glormerulonephritis give higher echogenicieties the later is characterized by small kidney loss of corticomedulary differentiation.

2.3.11Hydronephrosis

Is the separation of renal sinus echoes by interconnected fluid filled areas. In patient with progressive obstruction the renal parenchyma is compressed. If the hydronephrosis is suspected, on the ultrasound we should evaluate the bladder. If it's full, post void longitudinal scan of each kidney should be done to show that hydronephrosis has disappeared or remained the same; at the level of the obstruction we should sweep the transducer back and forth, in two planes to see if a mass or stone can be distinguished. There are three grades of hydronephrosis grade 1 entails small separation of the calceal pattern, also known as splaying. So we have to rule out a Parapelvic cyst The septation may be numerous or renal vessels in the Parapelvic area color flow is extremely useful. An extrarenal pelvis would protrude outside of the renal area, so we would not confuse this pattern probably with hydronephrosis. (David Sutton, 2002).

2.4 Physics and equipment

2.4.1 Understanding the physics behind the use of U/S

US waves are a form of sound waves. Its frequencies exceed the upper limit of audible human hearing. Medical US frequencies are in the range of 1-20 MHz. Each US wave is characterized by a specific frequency and wavelength, which are inversely related (2.6). Frequency is the number of cycles per second and is measured in Hertz.

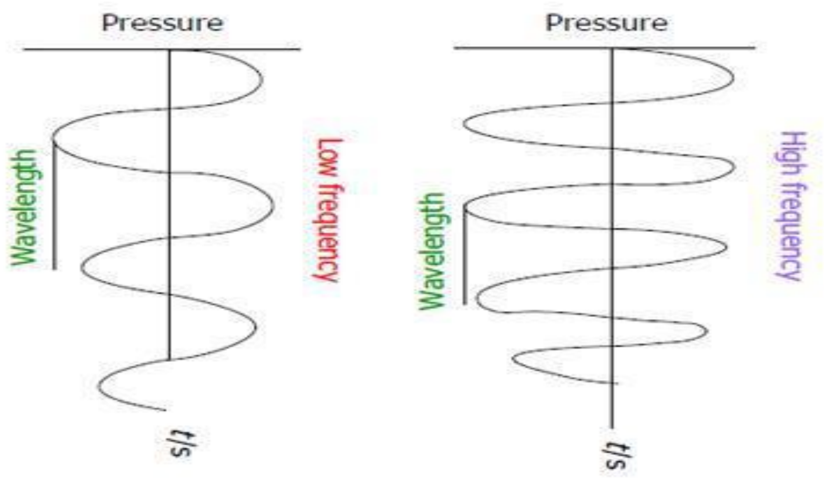

Fig (2.8) Ultrasound waveform. (Shanthanna H, 2014)

Wavelength is the distance between two consecutive, similar positions in the pressure wave. It is determined by the frequency of the wave, and the speed of propagation in the medium it is passing through. Actually the speed of sound is different based on the tissues through which it propagates. However it is averaged as approximately 1540 m/s for the entire body and is referred to as propagation velocity or acoustic velocity. The US waves are produced by piezoelectric effect, which was discovered by Curie brothers in 1880. It involves the generation of an electrical charge, by a piezoelectric material, when subjected to mechanical stress and the reverse piezoelectric effect involves such an electrical charge being converted to mechanical vibration. In the available US machines the transducer holding the piezoelectric material acts both as a generator and receiver of such signals. US used in medical imaging are referred to as B-mode (2D), meaning brightness mode display. This means the brightness of the pixel on the image is a representation of the strength of reflection. A source of alternating current makes the piezoelectric crystals to vibrate at high frequency producing US waves. This is then transmitted to the patient through a conductive gel. (Shanthanna H, 2014).

2.4.2 US equipment

Medical US utilizes a transducer attached to a display monitor which also holds the operating console. A transducer (also known as probe) contains a damping material, piezoelectric crystals, a matching layer and a protective layer (2.6). Each crystal is isolated and hence transmits its own US wave. The damping layer, present just behind the crystals acts to reduce their resonance so that they are sensitive to the returning signal. The matching layer in front acts to reduce the impedance mismatch and is covered by a protective layer.

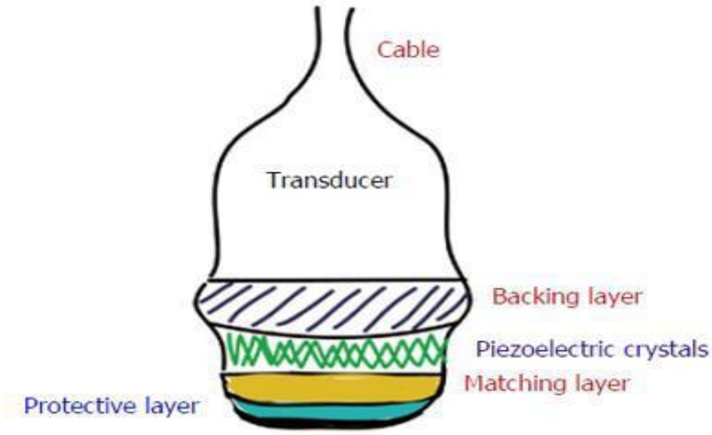

Fig (2.9) Typical transducer. (Shanthanna H, 2014)

There are several types of transducers and it is necessary to choose the right one for the procedure. Some others give 3 varieties, based on the range: high- (8-12 MHz), medium (6-10 MHz), and low (2-5 MHz). The smaller one with a straight contact surface is called a linear array transducer due to the linear arrangement of crystals. It also produces high frequency waves in the range of 8-12 MHz. Its penetration, and hence resolution is usually good for structures within 3-4 cm. The larger one with a curved contact surface is called a curved array or curvilinear transducer because of the curved arrangement of crystals. It creates a wedge shaped US beam and produces a much broader view with the image of deeper structures being wider than the footprint of the probe. It is used to visualise deeper structures, beyond 4 cm. It is important to know that the width of the image is equal to the probe footprint size only at the uppermost part of the image and hence any determination of depth is tricky. (Shanthanna H, 2014).

2.4.3 U/S Tissue Interaction

Once generated the wave passes through various tissue structures and thereby interacts with them. US waves are primarily influenced by physical changes involving reflection, refraction and attenuation. The reflected wave, which gives rise to the resulting signal, is dependent upon the underlying structures the waves encounter. This property is called acoustic impedance. It is unique to each tissue type and is defined as the density of the medium times the velocity of US wave transmitted through it. Less dense organs such as lungs have lower impedance in contrast to bones which would have higher impedance. The greater the differences in acoustic impedance between 2 adjacent tissues, more waves are reflected back. So it is not individual acoustic impedances but the relative difference of it among adjacent tissues that control the amount of energy reflected back.

Specular reflection involves a large smooth surface, such as a needle. Depending upon the incident angle, a large amount of US waves is reflected back to the transducer. Scattered reflection involves an irregular surface giving rise to scattering and hence loss of signal. Refraction involves changes in the direction of US waves due to an interface of tissues with different speeds of sound transmission. It is related to the depth of beam penetration. (Shanthanna H, 2014)

2.4.4 Understanding the controls and improving the image quality

A good use of US guidance can only be made when one understands how to operate the equipment and also how to modify the variables to get the best possible image. The following section gives an understanding of these elements.

Resolution: It describes the ability to separately identify to individual structures. Axial resolution refers to the possible differentiation between the 2 objects in the plane of US beam. Higher frequencies and superficial structures give better axial resolution. Temporal resolution refers to the rate at which consecutive images are visualised. It depends on the frame rate or pulses. A transducer emits the next pulse only after it has received the previous pulse. Increasing the depth of US beam affects the temporal resolution. Similarly, using Doppler has the same effect as it requires more time to process the incoming signals and hence lower temporal resolution. Lateral resolution refers to separation of structures lying side by side. Inappropriate use of focus zone-as explained below can decrease the lateral resolution. Contrast resolution is referred to the optimal visualisation achieved in terms of hyper and hypoechogenic structures displayed on the screen. To enhance visualisation and to improve resolution there are 3 important settings which can be altered.

Gain: This simply refers to the strength of the signal. The brightness of the image is proportional to the strength of the signal received by the transducer.

Focus: The sound waves converge to a point called focal zone and then diverge. The divergence of these waves beyond the focal zone can allow or missed information in a horizontal plane. To minimise this loss, it is important to set the focal zone at the same level as the target of interest.

Time gain compensation: As the name suggests there is an increase in gain (signal strength) which is restricted to a set field of depth. Attenuation increases with increasing depth. To compensate for this time gain compensation (TGC) allows for stepwise increase in gain which can be adjusted for a particular depth.

Frequency: Waves of higher frequency are more attenuated. One should choose a higher frequency probe for superficial structures, and low frequency probe for deeper structures.

Color Doppler : This function helps to detect structures with movement, like blood flow. It is based on the doppler principle. Structures moving away from the probe appear blue and those towards the probe appear red. One important thing to remember is that the angle of incidence should be as less as possible. With an angle of incidence of 90°, no flow is detected and might provide a false negative implication. To help visualise even smaller vessels and also to be independent of the incident angle, newer machines have power Doppler. (Shanthanna H, 2014)

2.4.5 Artifacts associated with US imaging

The image produced on the monitor is a 2 dimensional image obtained from converting mechanical energy into electrical signals. The actual conversion of signals into images involves several assumptions on the part of equipment’s software. These give rise to artifacts: could be a distortion in the image brightness, duplication, absence of echoes, etc. Commonly understood artifacts are described below.

Acoustic shadowing: This happens when a superficial structure has greater attenuation coefficient than the structures deep to it. Due to this the underlying structure appears less echogenic than normal.

Posterior acoustic enhancement: This is almost the opposite of shadowing. Due to the presence of a less attenuating structure superficially, the region behind that structure produces stronger echoes than the surrounding structures.

Reverberation: It is the multiple representation of the same structure at different depths of display. It is usually caused by a specular reflector such as a needle. It reflects a strong signal back to the tranducer, some of which is again reflected back to cause a repeat of the shadow at a different depth, because of the time delay involved.

Mirror image: It is a type of reverberation artifact, commonly produced due to a significant mismatch in the acoustic impedance between 2 adjacent structures such as air-bone, soft tissue-lung etc. appears in all modes including doppler.

Refraction: This is also called as bayonet effect. This appears as a subtle bend in the length of the needle due to refraction.

Dealing with artifacts: (1) Have a high degree of suspicion; (2) Confirm in 2 views, longitudinal and cross-sectional; (3) Change the position of transducer-move proximal or distal; (4) Reduce gain; and (5) Move the patient. (Shanthanna H, 2014).

2.5 Ultrasonography of the Kidney and techniques

Ultrasonography is used for anatomy, intra venous urography for anatomy and function, and nuclear medicine for function. Evaluation the kidney with u/s is noninvasive approach. It delineates retroperitoneal masses or fluid collection such as hematomas or abscesses, it's also rules out the hydronephrosis and fluid filled structure like cysts. It determines the renal size and parenchymal details, detect also upper ureter and renal congenital abnormalities. (B.Breyer; et al, 1995), (Gratton, Denis, 2005).

2.5.1 Patient Preparation

Patient fasting six hours prior exam with drinking water to fill the bladder before examination. When the patient is over hydrated, the internal collecting system will become distended but if the patient is dehydrated renal pelvic will be collapsed. (Gratton, Denis, 2005).

2.5.2 Patient Position

The examination begins with the patient in the supine position or decubitus position scans are performed in the sagittal and transverse planes from the anterior approach using the liver and spleen as acoustic windows for the right and left kidney respectively. Scanning is also done in deep suspended aspiration. Start with longitudinal scan over the right upper abdomen and then follow with transverses scan. Next, rotate the patient to the left lateral decuibitus position to visualize the right kidney in the coronal view. To visualize the left kidney, scan the left upper abdomen in a similar sequence, if the left kidney cannot be seen usually due to excess bowel gas; try the right lateral decubitus position. If the kidney cannot be imaged adequately, scan through the lower intercostals spaces. Turn the patient prone and apply enough gel to the left and right renal areas and perform longitudinal and transverses scan. Both kidneys can be also examined with the patient sitting or standing erect, when examining any part of kidney, compare both kidneys in different projection. Variations in size counter and internal echogenicity may indicate abnormality. For adults use 3.5 MHZ transducer, children and thin adults use a 5.0 MHZ start by placing the transducer over the right upper abdomen, then angle the beam as necessary and adjust the time gain compensation (TGC) with adequate sensitivity setting to allow uniform acoustic pattern, thus obtaining the best image of renal parenchyrna. Gain is amplification of the reflective ultrasound waves by the unit. The near gain control amplifies echoes returning from tissue above the focal point of the beam. While the far gain control amplifies echoes returning from beyond the focal point of the beam. E.g. echoes coming from deeper tissues need more amplification. These controls can be adjusted to allow the proper comparison of echogenicity at different level.

Renal detail may be obscured if there is significant amount at perirenal Fat, hepatocellular diseases, gall bladder stones, rib interface or other abdominal masses, or collection of fluid between the liver and kidney. When scanning the kidney it is better to identify the renal capsule, the cortex, the medulla sinus, upper ureter, renal arties and vein.

The kidneys are imaged by U/S as organs with smooth outer contours surrounded by highly echogenic perirenal fat. The renal capsule appears as a bright echogenic line surrounding the cortex which is homogonous with smooth counter, its echogenicity is moderated (mid to lower level echoes). In an even texture that is less echogenic than the normal liver or spleen but more echogenic than the adjacent renal medullary pyramids. The renal contains the pyramids which appear as triangular or blunted hypo echoic to an echoic area (it should not be mistaken for renal cyst or tumors). (B.Breyer; et al, 1995), (Gratton, Denis, 2005)

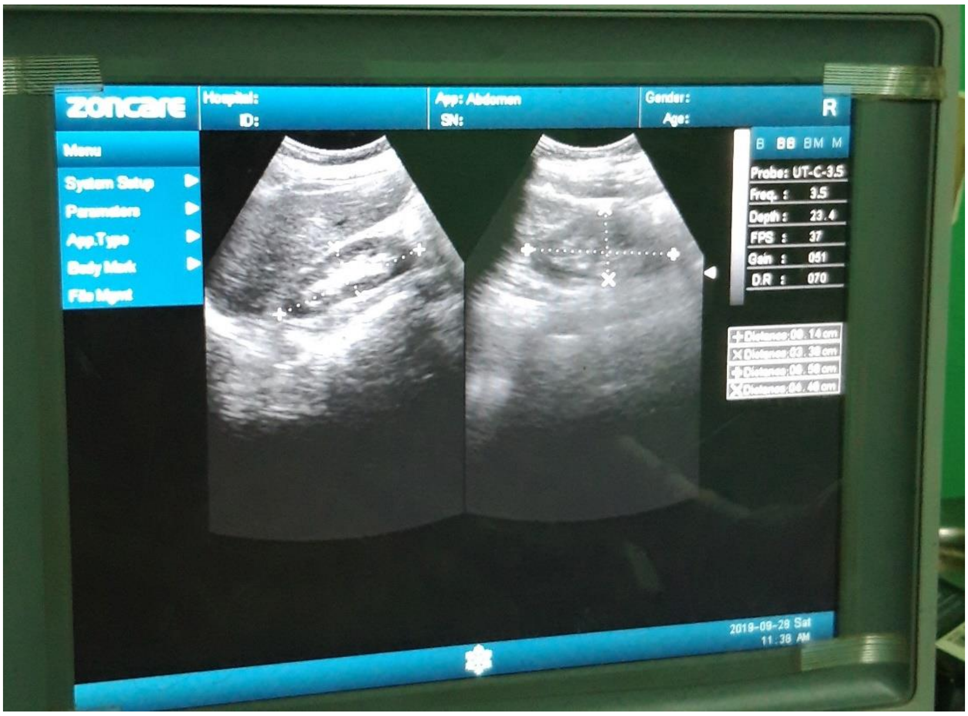

Fig (2.10) shows the normal kidney ultrasound longitudinal of the right kidney and left kidney

2.6 Previous Studies

Aisha O.A.O(July to October 2016) study done in sudan university and technology on 50 adult patients (25 females, 25 males) who are found to be of unknown renal diseases were examined according to the age, sex & BMI, aging between 16 - 65 years, in Elehtiati Elmarkazi Hospital.

Measurement includes length, width and thickness estimation of the renal volume which is obtained by multiplying the three variables by 0.523, the factor age, sex, body mass index and right and left kidney side are statically analyzed.

The mean right kidney length is (10.16 ± 0.61cm) …. The mean right kidney width is (4.61 ± 0.30cm) the mean right kidney depth is (4.10 ± 0.25cm).

The mean left kidney length is (10.56 ± 0.53cm) …. The mean left kidney width is (4.83 ± 0.29cm) the mean left kidney depth is (4.41 ± 0.24cm).

The mean right kidney volume is (100.55 ± 12.29cm^3) and the mean left kidney volume is (116.95 ± 11.58cm^3), Length did not significantly differ between right and left. However, the kidney width in the right is smaller than the left one. The only significant factors affecting the renal volume is the sex, age, BMI and right or left side.

The study concludes that there was no relation between renal volume and BMI, also there was no relation between renal volume and age.

The volume in male (106.06, 122.39) is slightly more than in females (95.03, 111.50)…(RKV, LKV), with the left kidney volume lager than the right. The mean volume of kidney in the left side (116.95) is larger than the right one (100.55).

Northwestern Nigeria study done in Bayero University, in a tertiary Hospital between January and December 2013, Study of the renal size in individuals without known renal disease, performed on 104 consecutive volunteers. There were 50 females and 54 males. Study show a mean length of 11.6 cm and 11.3 cm left and right, respectively. These values are slightly higher when compared with the Indo-Asian average length of 10.4 cm and is probably a reflection of the relatively small body size of most of the Indo-Asians, that left kidney is larger than the right (The renal volume was 109.6 ± 29.3 and 119.7 ± 32.8 for right and left kidney), with the findings that males have larger kidney volume, with volume of 206 cm^3 and 205 cm^3 for both right and left kidneys, respectively, however, there were no gender-related differences in renal length. The strongest correlation with renal volume is age, the correlation coefficient was 0.997, with positive correlations between renal volume and height, and body mass index. (Maaji SM, et al, 2015).

Iraqi study done in Sulimaniya University in 2013 - 2014 study of the renal size in ultrasound of unknown renal diseases. The study includes 450, 239 females 211 males. They found the results are nearer to the studies done in other nearby countries. They come to a conclusion that the BMI, ethnic, and environment are the main factors affecting the renal size. There was a positive correlation between the size of the right and left kidney, with the left kidney size which is larger (The mean of the left kidney size was 89031.0296 mm^3 with a standard deviation of 22025.83057, while the mean of the right kidney size was 72210.9842 mm^3 with a standard deviation of 18681.46873). There was also a positive correlation between renal size and age, as renal size increased with age till the 5th decade of life. While the male renal size was greater than the female renal size with the same age group, there was a positive correlation between renal size and body mass index (BMI). (Karim, Shilan Hussein et al, 2015).

A study done in Pakistan, ultrasonographic renal size in individuals without known renal disease. The study population were (194) male 98, females were 96, they come to find, Mean renal size in Pakistani population are significantly smaller than reference values available in literature from American and European population; the findings: A direct relationship between BMI and the renal size is in Pakistani population, the mean renal size correlated with age, female kidneys were significantly smaller than the male kidneys, with Left kidney is significantly larger than the right. (Buchholz, N., et al, 2000).

Material and Method

3.1 Material

3.1.1 Patient

The study was including 102 persons; out of which (71) were females and (31) were males at the Elsifa center , Almutakamel center and Ahbab almustafa center ; ranging between 5-75 years old during the period from November to December 2018. The study population consisted of outpatients undergoing US examination due to common clinical complaints such as weight loss, unexplained abdominal pain, nausea and constipation.

3.1.2 Inclusion criteria

- Adults with normal renal laboratory findings (RFT include BU and S creatinine, UG and electrolyte)
- No symptoms related to renal impairment such as lower limbs, periorbital swelling or abdominal ascites.
- Normal ultrasound findings (normal renal echogenicity, cortical thickening and corticomedullary differentiation)

3.1.3 Exclusion criteria

- Patients less than 5 years old with abnormal laboratory findings were excluded
- Abnormal ultrasound findings such as increased parenchymal echogenicity, abnormal cortical thickening and corticomedullary differentiation , renal cysts, hydronephrosis, single kidney, kidney stone and mass, extreme obesity or pregnancy
- Symptoms related to renal impairment.

3.1.2 Machine used

Description: Used / Refurbished Shimadzu SDU 350XL portable ultrasound

Obs/Gyn machine

S/W ver 5.11

3.5MHz Convex probe

Dual port connector

equivalent receptacle marked 'Hospital Only' or 'Hospital Grade'.
超音波診断装置
DIAGNOSTIC ULTRASOUND SYSTEM
MODEL SDU-350XL
SN 036P414405
V ~200-240 Hz:50/60
VA 200
PROTECTION CLASS I TYPE BF
MANUFACTURED: KYOTO
株式会社島津製作所 604-8511 京都市中京区西ノ京桑原町1
SHIMADZU CORPORATION
1.Nishinokyo-Kuwabaracho.Nakagyo-ku.Kyoto 604-8511.Japan
PAL
FUSE
INPUT ~100-120V
TYPE:T 3A/250V
INPUT ~200-240V
TYPE:TL 2A/250V

3.2 Methods

3.2.1Technique

The examination is performed on all patients. The subject lay in supine, lateral and prone positions; however, renal length, width and thickness of both kidneys for each individual were taken by ultrasound. Then, the renal length size for each kidney was calculated automatically by the machine .

Patient fasting six hours prior exam with drinking water to fill the bladder before examination.

The examination begins with the patient in the supine position or decubitus position scans are performed in the sagittal and transverse planes from the anterior approach using the liver and spleen as acoustic windows for the right and left kidney respectively. Scanning is also done in deep suspended aspiration. Start with longitudinal scan over the right upper abdomen and then follow with transverses scan. Next, rotate the patient to the left lateral decuibitus position to visualize the right kidney in the coronal view. To visualize the left kidney, scan the left upper abdomen in a similar sequence. Both kidneys can be also examined with the patients in prone position and apply enough gel to the left and right renal areas and perform longitudinal and transverses scan with using curve linear transducers, frequencies of 3.5 - 5 MHz have carried out.

3.2.2 Data Source

From direct ultrasound scanning of the population of study, from data sheet and request forms.

3.3 Data Analysis

The data were analyzed by the computer and protected by a pass word.

The data collected during the study were stored in the computer and protected by a pass word. All data collection sheets were protected in a private cabinet.

3.4 Consideration

There is no any patients name or individual patient`s details throughout the study.

Results

Table (4.1) frequency distribution of gender

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Male	31	30.4	30.4	30.4
Female	71	69.6	69.6	100.0
Total	102	100.0	100.0	

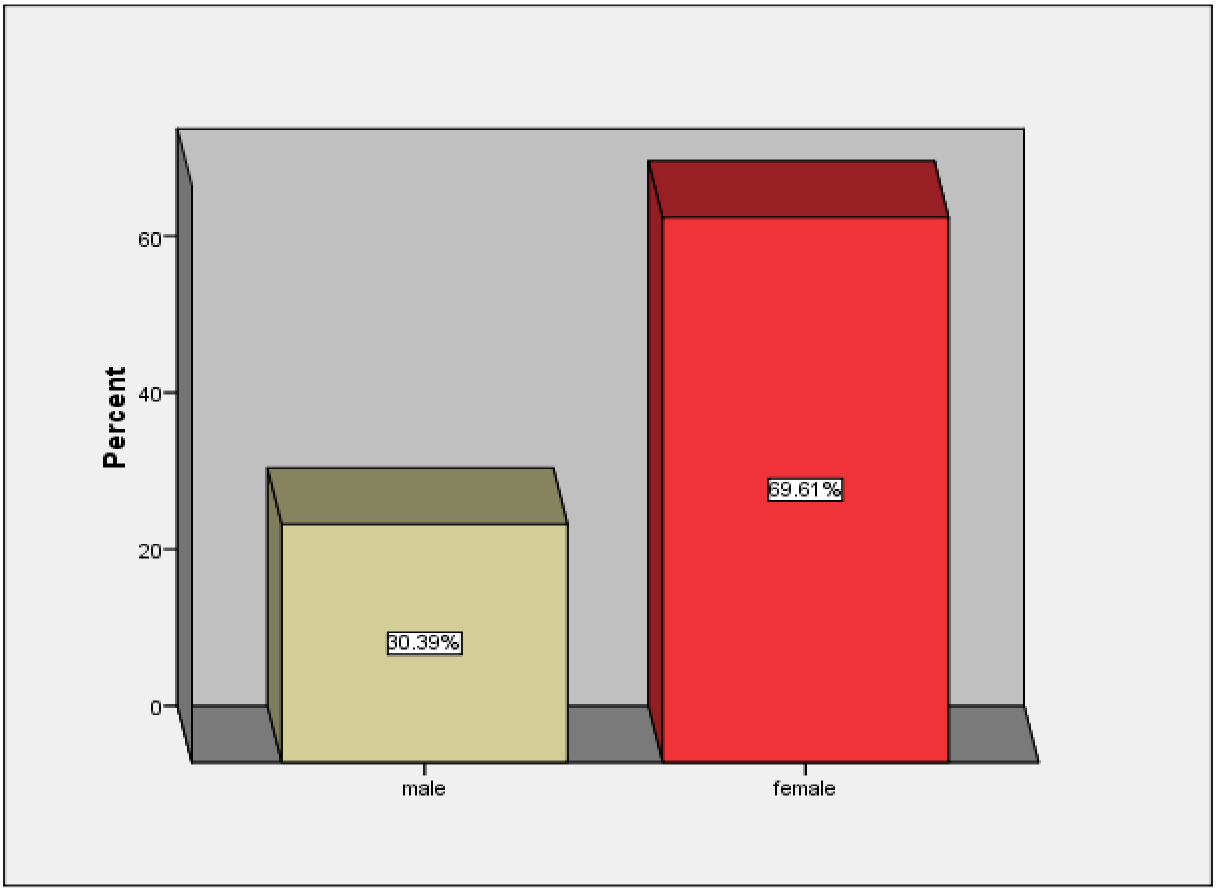

Figure (4.1) frequency distribution of gender

Table (4.2) frequency distribution of age\years

Age \years	Frequency	Percent	Valid Percent	Cumulative Percent
5-17	9	8.8	8.8	8.8
18-32	28	27.5	27.5	36.3
33-47	27	26.5	26.5	62.7
48-62	28	27.5	27.5	90.2
63-76	10	9.8	9.8	100.0
Total	102	100.0	100.0	

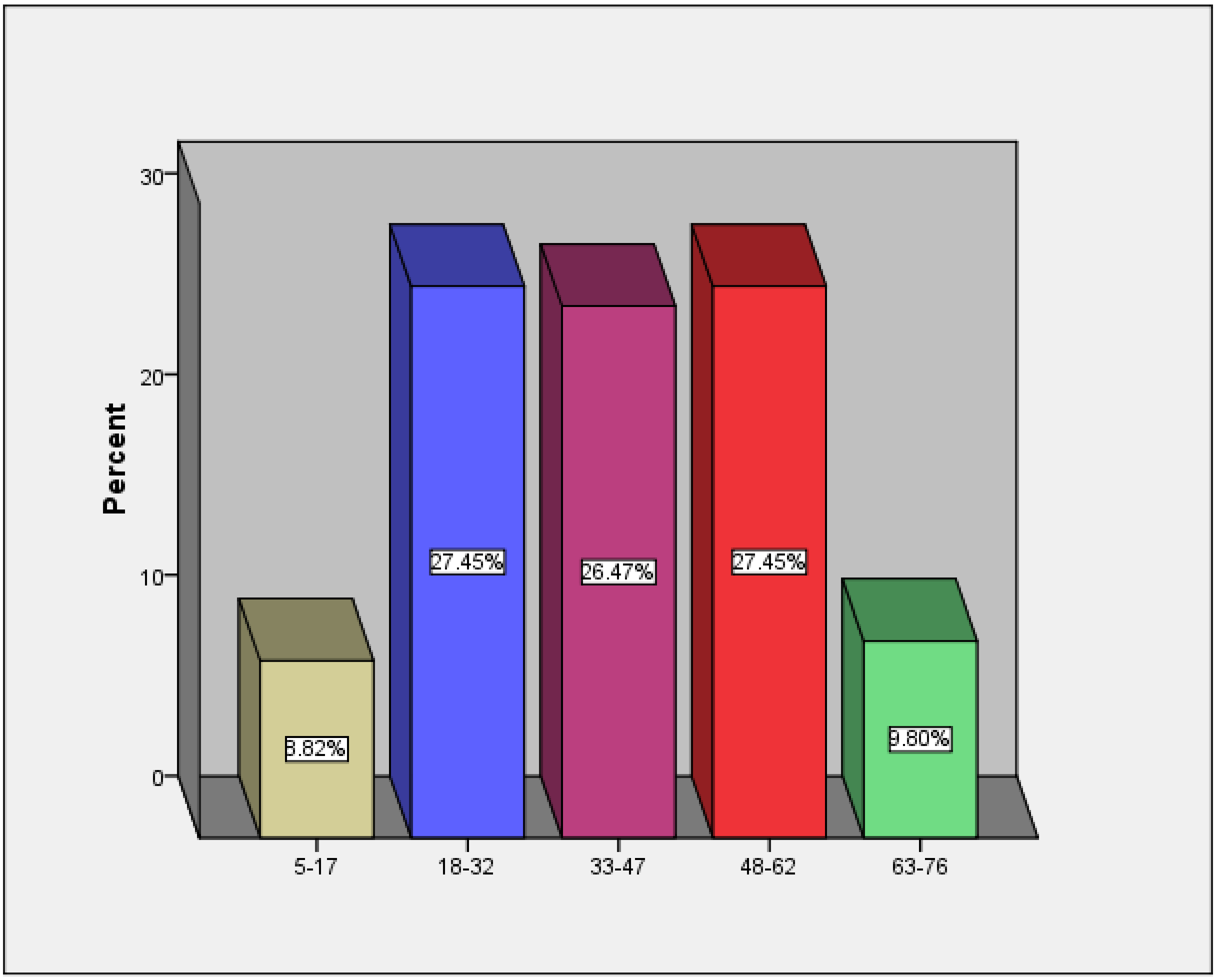

Figure (4.2) frequency distribution of age\years

Table (4.3) descriptive statistic of age\years, right and left kidney length

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Age	102	5	76	40.16	16.598
Right	102	7.1	11.9	9.655	1.0124
Left	102	7.5	12.3	10.105	1.0352
Valid N (listwise)	102				

Table (4.4) compare right and left kidney length in different age group

Age		right	left
5-17	Mean	8.100	8.467
	Std. Deviation	.4924	.5766
	Minimum	7.5	7.9
	Maximum	8.8	9.4
18-32	Mean	9.843	10.218
	Std. Deviation	.9024	.8115
	Minimum	8.5	9.1
	Maximum	11.8	12.0
33-47	Mean	9.878	10.433
	Std. Deviation	.7733	.7961
	Minimum	8.3	8.8
	Maximum	11.4	12.3
48-62	Mean	9.861	10.386
	Std. Deviation	1.1383	1.1420
	Minimum	7.1	7.5
	Maximum	11.9	12.2
63-76	Mean	9.350	9.590
	Std. Deviation	.5622	.6506
	Minimum	8.8	8.9
	Maximum	10.4	10.8
Total	Mean	9.655	10.105
	Std. Deviation	1.0124	1.0352
	Minimum	7.1	7.5
	Maximum	11.9	12.3
P value		0.000	0.000

Table (4.5) independent sample t-test for compare mean right and left kidney length in different gender

a. mean

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Age	male	31	43.10	18.755	3.369
	female	71	38.87	15.531	1.843
Right	male	31	9.800	.9227	.1657
	female	71	9.592	1.0490	.1245
Left	male	31	10.129	.9991	.1794
	female	71	10.094	1.0573	.1255

b. t. test for equality of means

	t-test for Equality of Means						
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	99% Confidence Interval of the Difference	
						Lower	Upper
age	1.184	100	.239	4.224	3.566	-5.140-	13.587
	1.100	48.781	.277	4.224	3.840	-6.069-	14.516
right	.956	100	.341	.2085	.2180	-.3641-	.7810
	1.006	64.602	.318	.2085	.2073	-.3417-	.7586
left	.155	100	.877	.0347	.2239	-.5533-	.6227
	.158	60.333	.875	.0347	.2190	-.5477-	.6171

Table (4.6) correlation between right and left kidney length and age

		age	right	left
age	Pearson Correlation	1	.198*	.215*
	Sig. (2-tailed)		.046	.030
	N	102	102	102
right	Pearson Correlation	.198*	1	.896**
	Sig. (2-tailed)	.046		.000
	N	102	102	102
left	Pearson Correlation	.215*	.896**	1
	Sig. (2-tailed)	.030	.000	
	N	102	102	102
*. Correlation is significant at the 0.05 level (2-tailed).				
**. Correlation is significant at the 0.01 level (2-tailed).				

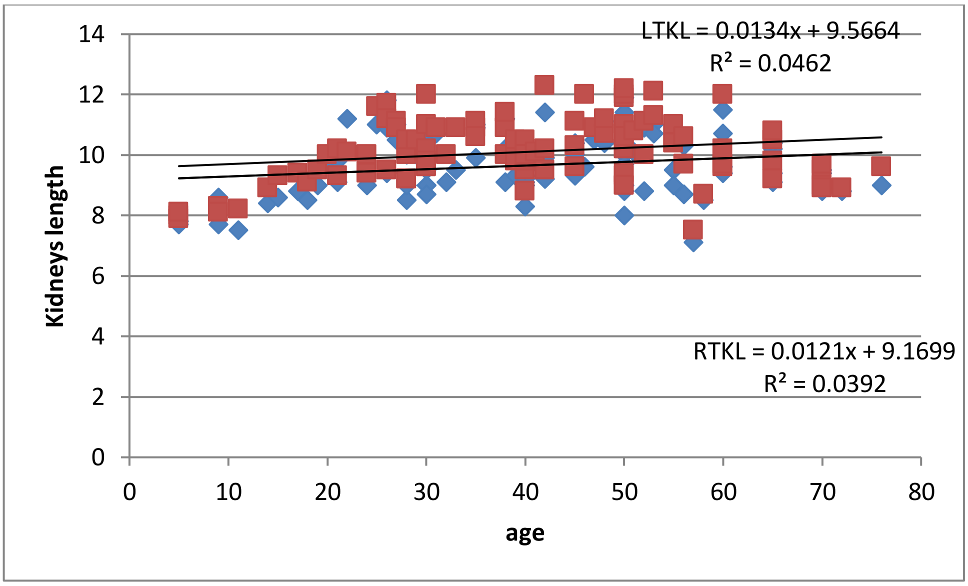

Figure (4.3) scatter plot shows relation between age and kidneys length

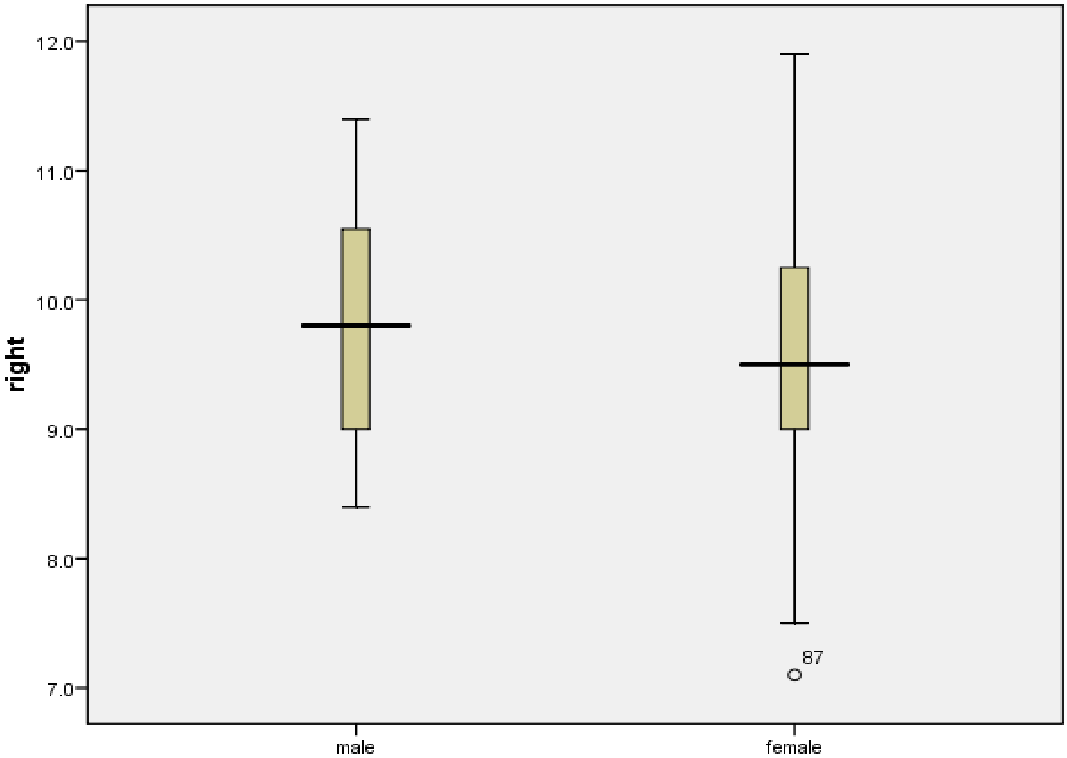

Figure (4.4) plot box for mean right kidney length in different gender

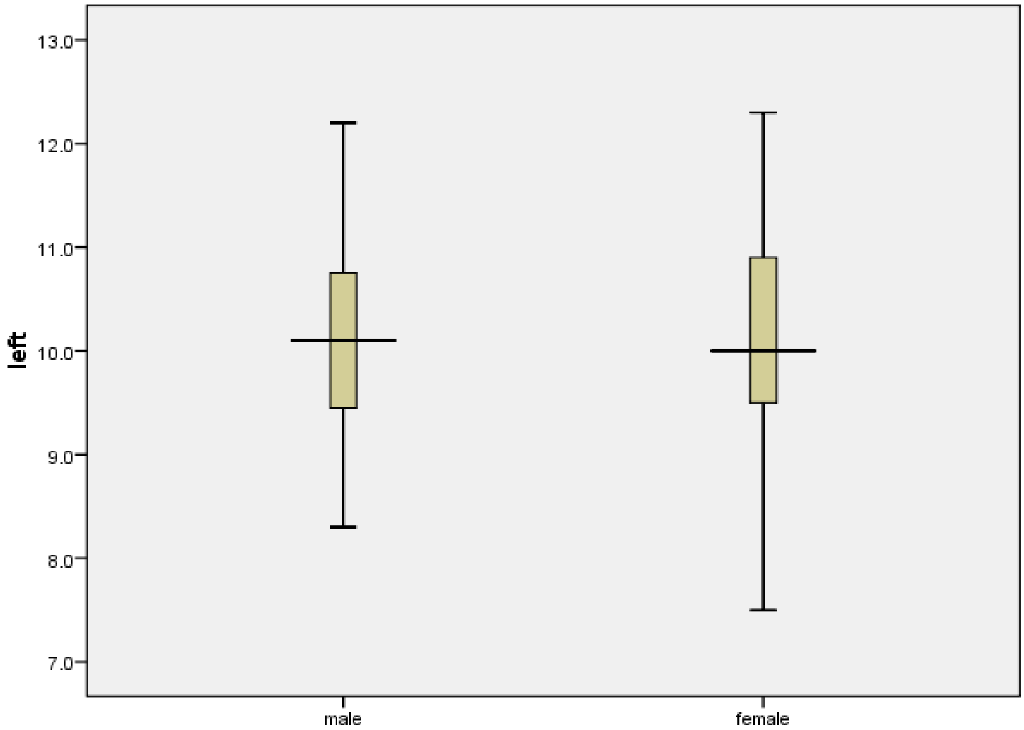

Figure (4.5) plot box for mean left kidney length in different gender

Chapter Five

Discussion, Conclusion & recommendation

5.1 Discussion

Study has been conducted at the ultrasound department of Alshfa center, Ahbab Almustafa center and Almutakamel center , 102 patients (31 male and 71 female) their mean age was 40 years.

The result of the study showed that the mean age was (40.16) years and SD was (16.598). Hence, both kidney length are shown in table (4.3). Calculation of correlation for both kidneys with age was done separately. The result showed that there was correlation between age and kidneys length, as shown in Fig (4.3). These findings not agree with previous studies conducted in Pakistan, where the length of the left kidney did not significantly differ from the length of the right kidney This finding further buttresses the fact that has already been known that the left kidney is bigger than the right in most people(Emamian et al., 1993).

Renal length for both kidneys has been measured separately for both sexes. The mean of the right renal length in male was (9.800 cm), the SD was (0.9227), while the mean of the left renal length was (10.129 cm). In females, the mean of the right renal length was (9.592 cm), the SD was (1.0490 cm), while the mean of the left renal length was (10.094), and the SD was (1.0573). The mean of the right renal length in both sexes and also the mean of the left renal length in both genders were compared so as to find whether there is a difference in the length or not. Hence, the correlation was significant. The right and left kidney length were larger in males than the right and left kidney length in females as can be seen in Fig(4.4) (4.5). Renal length have been found to be slightly larger in males in most studies, this agree with previous study (Karim, Shilan Hussein et al, 2015) (Buchholz, N., et al, 2000) (Aisha O.A.O, 2016).

5.2 Conclusion

The study concluded that the length of kidneys in males was slightly more than female, there was a signifance native correlation between age and the length of the kidneys in which as equations LTKL = 0.0134*age + 9.5664 , $R^2 = 0.0462$ and RTKL = 0.0121*age + 9.1699, $R^2 = 0.0392$.

Also study found that the left kidney length was larger than the right one.

5.3 Recommendations

- Study recommends that the Government should introduce the modern ultrasound machines and increasing the training institutes of ultrasound and computer programs for increasing the sonologists skills and experiences.
- If there is indication of renal disorder by U/S scanning, the patient images must be analyzes by IDL program, then the histopathology will be done for confirmation only, if it is not available, no need of it for giving the patient the treatment, because the prediction of U/S and texture analysis tools together is very high.
- The study recommended that the government should be increasing the specialist hospitals for renal diseases because they increased in Sudanese now days.
- According to the high cost of scientific research which the researcher was faced, the government should appeal universities in Sudan and companies to support the researchers in order to improve plans of treating and management of such diseases.
- Further studies should be carried out in this field on many aspects such as increasing the number of patients, to show the Ultrasound features of normal kidneys and diseased kidneys, comparing between the role of U/S scanning and other diagnostic tools using color Doppler ultrasonography.

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Data Sheet:

No	sex	age	right	left
1.	female	30	9	10
2.	female	53	11	11.3
3.	female	30	9	9.6
4.	female	28	10	10
5.	male	35	10.9	10.9
6.	female	30	10.5	12
7.	male	76	9	9.6
8.	female	40	9.1	9.5
9.	male	60	10.7	9.6
10.	male	22	11.2	10.1
11.	female	45	9.3	9.6
12.	female	28	10	10.5
13.	female	26	11.8	11.7
14.	female	27	11	11.1
15.	male	50	11.1	11.9
16.	female	50	10	10.2
17.	male	46	9.6	12
18.	male	15	8.6	9.3
19.	female	56	10.3	10.6
20.	male	9	8.6	8.3
21.	female	40	8.3	8.8
22.	female	30	10	10.2
23.	female	48	10.4	10.7
24.	female	55	9.5	10.4
25.	female	5	7.8	8
26.	female	45	10	10.3
27.	female	30	10.8	11
28.	female	40	9.3	10

29.	female	42	9.2	9.5
30.	male	24	9.9	10
31.	female	17	8.8	9.4
32.	female	25	11	11.6
33.	female	5	7.8	7.9
34.	female	70	9.4	9.5
35.	female	47	10.5	10.9
36.	female	39	10.2	10.5
37.	female	42	11.4	12.3
38.	female	5	7.7	8.1
39.	female	9	7.7	8.1
40.	female	35	11	11.1
41.	male	52	10.9	11.1
42.	male	48	11.1	11.2
43.	male	45	10.4	11.1
44.	female	60	9.6	9.7
45.	female	65	9.4	9.8
46.	female	50	11.9	12
47.	female	65	10.2	10.5
48.	male	50	11.4	12.2
49.	female	50	10.2	11
50.	female	38	10.2	10.9
51.	female	51	10.1	10.8
52.	male	14	8.4	8.9
53.	female	24	9	9.4
54.	female	38	11.2	11.4
55.	female	53	10.7	12.1
56.	female	50	8.8	9
57.	male	60	9.4	10.2
58.	female	60	11.5	12

59.	female	50	9	9.3
60.	female	50	9	9.4
61.	male	41	9.9	10.1
62.	female	65	9.1	9.2
63.	female	11	7.5	8.2
64.	male	50	10.4	10.6
65.	female	39	9.7	9.8
66.	female	33	9.5	10.9
67.	male	21	9.8	10.2
68.	male	40	10	10.5
69.	female	19	9	9.5
70.	female	35	9.9	10.6
71.	male	32	9.1	10
72.	female	52	8.8	10
73.	female	38	9.1	10
74.	female	29	10	10.5
75.	male	20	9.7	10
76.	female	21	9.1	9.3
77.	female	31	10.7	10.9
78.	female	50	9.7	10.2
79.	male	72	8.8	8.9
80.	male	40	9	9.8
81.	female	27	10.5	10.9
82.	male	70	9.5	9.7
83.	male	50	10.4	10.6
84.	female	55	9	11
85.	female	50	8	9
86.	female	28	8.5	9.2
87.	male	58	8.5	8.7
88.	male	28	9	9.2

89.	female	56	8.7	9.7
90.	female	57	7.1	7.5
91.	female	40	9.2	9.9
92.	female	26	9.4	9.5
93.	male	70	8.9	9
94.	female	30	8.7	9.6
95.	female	40	9.5	10
96.	female	39	9.3	9.9
97.	female	65	10.4	10.8
98.	female	18	8.5	9.1
99.	female	30	9.5	9.8
100.	male	42	9.9	10.2
101.	male	26	10.9	11.2
102.	male	70	8.8	8.9